NIOSH Safety and Health Topic:

Chest Radiography

Evaluating Occupational Lung Disorders

April 13, 2005

Notice: This is a draft Topic Page on which NIOSH is seeking public comment until **October 15, 2005.**

The National Institute for Occupational Safety and Health is using the issuance of the new International Labour Office (ILO) Classification of Radiographs as an opportunity to expand its Web site on the B Reader Program and use of the ILO system. NIOSH-certified B readers use the internationally-recognized ILO system to classify chest radiographs for the presence and severity of pulmonary parenchymal and pleural changes potentially caused by exposure to dusts such as asbestos, silica, and coal mine dust. The revised program Web site provides more information about radiographic reading and the ILO system including recommendations or "best practices" for use of the ILO system in different settings.

We are specifically seeking public comment for the draft document "Recommendations for Applying the International Labour Office (ILO) International Classification of Radiographs of Pneumoconioses in Medical Diagnosis, Research and Population Surveillance, Worker Health Monitoring, Government Program Eligibility, and Compensation Settings." Please review it and submit your comments to CWHSP@cdc.gov. If you would prefer to have a hard copy rather than electronic, please let us know, and we will be happy to fax or mail one to you. The document will remain available for comment until **October 15, 2005**. After that date, NIOSH will consider all the comments submitted and make appropriate revisions to the document before publishing a final version on this Web site.

Thank you in advance for your input. It is important to us that we consider many different viewpoints in this document. Also, we are interested in your feedback on the whole Web site. Please feel free to send any comments or suggestions to the same address.

The purpose of this Web site is to provide information to interested persons about radiograph reading as it relates to the pneumoconioses. Many aspects of radiograph reading are addressed on this site. For those in the professional audience (physicians, attorneys, workers' compensation specialists, case workers, etc.) you will find in-depth information on all aspects of radiograph reading. For those looking from a personal perspective, you will find information on radiograph reading as it relates to the eligibility for compensation in federal programs, as well as general information.

Topics such as the history and development of radiograph reading, how to become a certified B Reader, how radiograph reading relates to federal compensation eligibility, best practices for different radiograph reading applications, and issues in radiographic interpretations are included.

Chest Radiography (Draft for discussion)

Normal Chest Radiograph

Topic Index:

It is intended for this Web site to answer most questions on radiograph reading as it relates to the pneumoconioses either through provided information or provided links. However, if your particular question is not answered here, please contact us via email at CWHSP@cdc.gov.

Chest Radiography

- History of Radiograph Reading
- ILO Classification
- Applications for Chest Radiography in Occupational Health
- Issues in Radiographic Interpretation
- Recommendations for Applying the ILO International Classification of Radiographs of Pneumoconioses
- Resources
- Resources #2

B Readers

- NIOSH B Reader Certification Program
- B Reader Information for Medical Professionals
- Ethical Considerations for B Readers
- NIOSH Certified B Readers List

History of Radiograph Reading ▶

Certification Program

B Reader Information for Medical Professionals

Ethical Considerations for B Readers

NIOSH Certified B Readers List

Related NIOSH Topics:

Occupational Respiratory Disease Surveillance

Coal Workers' Health Surveillance Program

NIOSH Safety and Health Topic:

Chest Radiography

The NIOSH B Reader Certification Program

Background

History and Need

In 1949, the International Labour Organization (ILO) promulgated standards for reading and interpreting chest radiographs. The intent of the standards was to achieve uniformity in assessing pneumoconiosis. However, it was found that readers, despite employing the classification scheme, still disagreed with each other and with themselves to an excessive degree (Felson 1973). As a consequence, the National Institute for Occupational Safety and Health (NIOSH) concluded that a proficiency certification program was needed to provide a pool of qualified readers. The NIOSH B Reader Program began in 1974; although, it was not until 1978 that the certification exam was given extensively (Attfield 1992).

Intent/Objective

The B Reader examination was originally developed to identify physicians qualified to serve in national pneumoconiosis programs directed at coal miners and others who suffer from dust-related illness. This originally included epidemiologic research on coal workers' pneumoconiosis and the compensation of coal miners with pneumoconiosis under programs processed by government agencies (Morgan 1979). The original intent of the B Reader Program still exists, but B Readers are also now involved with epidemiologic evaluation and surveillance programs involving many types of pneumoconioses. By evaluating the ability of a reader to classify a test set of radiographs and certifying only those who achieve a certain level of proficiency, the B Reader Program is intended to ensure that physicians who read chest radiographs for evidence of pneumoconiosis using the International Labour Office (ILO) Classification system are as accurate and precise as possible.

Utility of B Reading

The B Reader test simply ensures that readers can demonstrate a certain competency in classifying a set of radiographs for the pneumoconioses and related diseases using the ILO system. The utility of the ILO system is now internationally accepted, having been repeatedly shown to lead to data appropriate for assessing disease prevalence, incidence, and its relationship to measured dust exposures. As Jacobsen has noted: "There are now several examples testifying to the value of the classification system in epidemiologic studies of the relationships between the occurrence, nature and intensity of pneumoconiotic appearances and the levels of exposure to dust of the individuals concerned. Quantitative statements about such exposure-response relationships play a key role in decision-making with respect to occupational and environmental hygiene standards." (Jacobsen 1991)

Chest Radiography (Draft for discussion)

Normal Chest Radiograph

Topic Index:

B Reading and the Law

The Federal Coal Mine Health and Safety Act was passed in 1969 following escalat ing concerns about coal workers' pneumoconiosis and the rising number of fatalities due to mining accidents. The Act was then updated in 1977 (Federal Mine Safety and Health Act of 1977, Public Health Law 91-173). One of the provisions of the Act was to provide preventive as well as compensatory services to miners afflicted with coal workers' pneumoconiosis (CWP) (see next section). Radiographs taken under the Act's provisions must be interpreted using the International Labour Office (ILO) Classification system and interpreted first by an A or B Reader. All subsequent readings must be done by a certified B Reader (42CFR37 external link). Another program is the Asbestos Medical Surveillance Program (AMSP) (external link), administered by the Navy Environmental Health Center. The Occupational Safety and Health Administration (OSHA) asbestos standard requires that chest radiographs obtained for surveillance of those exposed to asbestos be interpreted and classified by a B Reader, radiologist, or physician with expertise in pneumoconioses. OSHA (external link) also specifies B Readers and the International Labour Office (ILO) Classification in its asbestos safety and health standards for general industry, construction, and shipyard employment.

Example of B Reading at work: the NIOSH Coal Workers' Health Surveillance Program (CWHSP)

The NIOSH CWHSP is a surveillance program that was established as part of the Federal Mine Safety and Health Act of 1969. This program allows all underground coal miners the opportunity to receive chest radiographs for pneumoconiosis evaluation at no cost to the miner. Regulations mandate that all physicians who participate in the examination and/or classify chest radiographs under the Act must utilize the ILO Classification system and the ILO Standard Films for comparisons. B Readers evaluate the radiographs from the CWHSP for evidence of pneumoconiosis and use those findings to aid in the prevention of pneumoconiosis and to prevent the disease from progressing to a more advanced state. The first step in evaluating a radiograph for the CWHSP is for an A reader or B Reader from a NIOSH-approved radiographic facility to review the radiograph for coal workers' pneumoconiosis (CWP). Then the radiograph is sent to NIOSH where a B Reader reads the radiograph. If there is agreement, the miner is notified of the results. If there is not agreement between the two readers, then a third B Reader classifies the radiograph. If there is agreement between 2 of the 3 readers, a final determination is sent to the miner. If no agreement is obtained, the radiograph is read by a panel of B Readers, and their classification is considered the final determination. This is then sent to the miner (42CFR37 external link). For more information on the CWHSP, visit the CWHSP Web site.

Certification

*** If you are a physician interested in becoming a B Reader, follow this link for more information (B Reader Information for Medical Professionals).**

Exam Description and Certification Process

The B Reader examination process has been in existence since 1978 with prototype development starting in 1974. The examination consists of the classification of 125 chest radiographs over a period of 6 hours. The test is scored out of 100 points with a passing score being a combined score of fifty or more points. There are six sections to the examination: small opacities (3 parts), large opacities, pleural abnormalities, and other abnormalities with the scoring weighted towards parenchymal abnormalities (60%). From 1987 to 1990, about 47% of readers passed the examination. Once certified a reader must

NIOSH B Reader Certification Program

B Reader Information for Medical Professionals

Ethical Considerations for B Readers

NIOSH Certified B Readers List

On This Page...

Background

Certification

Recertification

A Readers

New Developments and Future Challenges

Comments and Concerns

References

Related NIOSH Topics:

Occupational Respiratory Disease Surveillance

Coal Workers' Health Surveillance Program

recertify every four years (see Recertification below).

Reader Training

NIOSH strongly recommends pre-test preparation for examination participants to assure familiarity with the International Labour Office (ILO) Classification system and associated Roentgenographic Interpretation Form.

NIOSH Home Self-Study Syllabus

The Syllabus is available by mail in the U.S. on a first-come, first-served basis from the Appalachian Laboratory for Occupational Safety and Health (ALOSH) prior to scheduled testing. Additionally, the Syllabus may be used on-site by anyone interested in coming to Morgantown to study prior to taking the examination. To request the Syllabus, contact the CWHSP at (888) 480-4042 or email CWHSP@cdc.gov.

American College of Radiology Symposium on Pneumoconioses

The American College of Radiology (ACR) Symposium on Radiology of the Pneumoconioses is usually held every 2-3 years. The last symposium was held March 2004, in McLean, Virginia.

Calendar of Events

Exams are offered monthly at ALOSH. For scheduled dates, please call (888) 480-4042 or email CWHSP@cdc.gov.

The ACR does offer testing during their symposiums. For more information on ACR symposiums, please visit their Web site at American College of Radiology (external link).

Recertification

The recertification process began in 1984. B Readers must recertify every four years; however, physicians may recertify during their last year of certification. The recertification exam is very much like the certification exam, except readers are required to classify only fifty radiographs. If a reader fails the recertification exam, they must take the original certification examination before expiration of their current certification in order to remain certified. There is no waiting period between failing the recertification and taking the certification exam. However, if they fail the certification exam, readers must wait six months before retaking it (Wagner 1993). B Readers who do not take the recertification exam before expiration of their certification automatically become A Readers.

A Readers

An A Reader is a physician who has demonstrated proficiency in classifying the pneumoconioses by one of three methods. They may submit to the Appalachian Laboratory for Occupational Safety and Health (ALOSH) six sample chest radiographs, which they have properly classified. These radiographs will be evaluated by a panel of B Readers. The six radiographs must include two films without pneumoconiosis, two films with simple pneumoconiosis, and two films with complicated pneumoconiosis. The second method for becoming an A Reader requires satisfactory completion of one of the American College of Radiology's Symposium on the Classification of Radiology for the Pneumoconioses. Finally, B Readers who fails to recertify before the expiration of their certification automatically

become A Readers.

New Developments and Future Challenges

Digital Radiography

Conventional film screen chest radiography has been widely applied in assessing lung health in dust-exposed workers for decades, but this technique is being replaced by digital radiography systems. NIOSH is currently assessing the equivalency of traditional radiography and digital radiography with respect to pneumoconiosis classification using conventional and digital images from patients with a spectrum of dust-related lung disorders and chest pathology. However, until authoritative recommendations applicable to use of digital images have been specified, NIOSH recommends that B Readers using the ILO Classification continue to use traditional film screen radiographs and standards.

ILO 2000 Revisions

The ILO revised its Classification system in 2000 and published updated Guidelines in 2002. To assure adherence to this new system, NIOSH has modified the B Reader examinations and related training activities and materials, including the Self-Study Syllabus and Film Set. The goal of this effort is to maintain the NIOSH B Reader Program as a contemporary and relevant quality assurance program for the classification of chest radiographs for occupational lung disease research and prevention.

Syllabus on Compact Disc

Currently, the Self-Study Syllabus and Film Set are available by mail in the United States from NIOSH on a first-come, first-served basis. Additionally, the Syllabus may be used on-site by anyone interested in coming to NIOSH, Morgantown or at nine other locations across the country and at 18 international sites. NIOSH is working to put the entire Self-Study Syllabus and Film Set on compact disc to increase availability of the Syllabus to each test taker.

Comments or Concerns

Comments or Concerns about the B Reader Certification Program

The B Reader Certification Program welcomes any comments or concerns about the Program, the examination, or this Web site. Our goal is to serve all persons who interact with this Program and continuously improve the information that we provide. Please use any of the following contact methods:

Call the Program office at (888) 480-4042

Email us at CWHSP@cdc.gov

Mail the Program at:

ALOSH/NIOSH
Surveillance Branch
Coal Workers' Health Surveillance Activity
P.O. Box 4258
Morgantown, WV 26504

Comments or Concerns about Specific B Readers

The purpose of the B Reader Certification Program is to train licensed physicians in use of the ILO Classification System and to certify their ability to apply the ILO Classification System in classifying chest radiographs for the presence and severity of changes potentially associated with exposure to dusts such as asbestos, silica, and coal mine dust. Classifying chest radiographs is practicing medicine. In the United States, licensure to practice medicine is regulated at the State level by State medical licensing boards. Physicians should not classify chest films and may not take either the B reader certification examination or quadrennial recertification examinations unless they possess a current, active license to practice medicine. Complaints about a specific physician certified as a B reader should be referred to the appropriate State medical licensing board, as these boards are the bodies responsible for assuring competence and integrity of licensed physicians. Contact information for each State's medical licensing board can be found on the Federation of State Medical Boards Web site (external link).

References

Felson B, Morgan WKC, Bristol LJ, Pendergrass E, Dessen EL, Linton OW *et al.* Observations on the results of multiple readings of chest films in coal miners' pneumoconiosis. Radiology 1973;109:19-23.

Attfield MD, Morring K. An investigation into the relationship between coal workers' pneumoconiosis and dust exposure in U.S. coal miners. *Am Ind Hyg Assoc J* 1992; 53:486-92.

Morgan RH. Proficiency examination of physicians for classifying pneumoconiosis chest films. *Am J Roentgenology* 1979;132:803-08.

Jacobsen M. Part 5. Radiologic Abnormalities: Epidemiologic Utilization: The International Labour Office Classification: Use and Misuse. *AnnalsNew YorkAcademy of Sciences* 1991; 643:100-107.

Federal Mine Safety and Health Act of 1977, Public Health Law 91-173

Specifications for Medical Examinations of Underground Coal Miners. 42CFR37
External Link: http://www.access.gpo.gov/nara/cfr/waisidx_02/42cfr37_02.html

Asbestos Medical Surveillance Program. Navy Environmental Health Center
External Link: http://www-nehc.med.navy.mil/occmed/Asbestos.htm

Safety and Health Topics: Asbestos. Occupational Safety and Health Administration
External Link: http://www.osha.gov/SLTC/asbestos/index.html

Coal Workers' Health Surveillance Program. National Institute for Occupational Safety and Health

B Reader Certification Program. National Institute for Occupational Safety and Health

Roentgenographic Interpretation Form. B Reader Certification Program. National Institute for Occupational Safety and Health

American College of Radiology
External Link: http://www.acr.org/s_acr/index.asp

Wagner GR, Attfield MD, Parker JE. Chest Radiography in Dust-Exposed Miners: Promise and Problems, Potential and Imperfections. *Occupational Medicine: State of the Art Reviews* 8(1); 127-141, 1993.

Federation of State Medical Boards
External Link: http://www.fsmb.org/members.htm

◀ Resources B Reader Information for Medical Professionals ▶

NIOSH Home | NIOSH Search | Site Index | Topic List | Contact Us

NIOSH Safety and Health Topic:

Chest Radiography

B Reader Information for Medical Professionals

If you are visiting this Web Page, you may be interested in the NIOSH B READER program or you may be curious about becoming approved as a NIOSH B Reader.

--Do you live in a coal mining area and expect to classify chest radiographs for the Coal Workers' X-Ray Surveillance Program as mandated by the Federal Mine Safety and Health Act of 1977?

--Have you been asked to classify chest radiographs of asbestos- exposed workers as governed by the U.S. Department of Labor regulations?

--Are you involved in classifying chest radiographs for medical screening, surveillance, research, or compensation programs?

The B Reader Examination

NIOSH B Reader approval is granted to physicians who demonstrate proficiency in the classification of chest radiographs for the pneumoconioses using the International Labour Office (ILO) Classification System.

Proficiency is evaluated via the NIOSH B Reader Certification Examination, which was developed in response to the mandates of the Federal Mine Safety and Health Act. Since the examination was first administered in 1974, NIOSH has certified more than 1200 physicians. Currently, there are 531 certified B Readers. Upon request, NIOSH will provide a list of all currently certified B Readers.

Examinations are offered monthly at the Appalachian Laboratory for Occupational Safety and Health (ALOSH) located in Morgantown, West Virginia. A passing score results in approval as a NIOSH B Reader. Each B Reader receives a certificate and is required to recertify at four-year intervals. Nearly 56% of NIOSH-certified B Readers renew certification for an additional term.

Regulations mandate that all physicians who participate in the examination and/or classify chest radiographs under the Act must utilize the ILO System and Standard Films. These standard films are necessary when participating in the B Reader Examination or utilizing the NIOSH Self-Study Syllabus, and are an important resource at the American College of Radiology (ACR) Symposium on Radiology of the Pneumoconioses.

For more information:
Wagner GR, Attfield MD, Parker JE. Chest Radiography in Dust-Exposed Miners: Promise

Chest Radiography (Draft for discussion)

Normal Chest Radiograph

Topic Index:

and Problems, Potential and Imperfections. OCCUPATIONAL MEDICINE: State of the Art Reviews. Philadelphia, Hanley & Belfus, Inc. 1993; 8(1):127-141.

For additional information, you may wish to refer to:
Wagner GR, Attfield MD, Kennedy RD, Parker JE. The NIOSH B Reader Certification Program--An Update Report. JOURNAL OF OCCUPATIONAL MEDICINE. 1992; 34:879-884.

New ILO Revisions

The revised edition (2000) of the Guidelines for the Use of the ILO International Classification of Radiographs of Pneumoconioses has been released. NIOSH is in the process of updating the entire B Reader Program to reflect these changes. Potential B Reader candidates should keep the following in mind:

- B Reader certifications under the previous ILO system will continue to be valid until their date of expiration.
- NIOSH has revised both the B Reader certification and recertification examinations to make them consistent with the ILO revision.
- A revised Roentogenographic Interpretation Form, consistent with the ILO revision, is now available from NIOSH and is being used in all components of the CWHSP. You may download a copy of the form from this site by clicking on the link above.
- NIOSH now tests all B Reader candidates according to the revised ILO system. Upon the expiration of their certification, current B Readers will be required to recertify under the revised system.

To order copies of the revised edition of the International Classification of Radiographs of Pneumoconioses, use the ILO Web site:

Log onto the ILO Web site External Link: http://www.ilo.org/
Under Highlights (right side of the page), click Publications
Select New Books
Select Titles Alphabetically
Select the letter "I"
Select "ILO Standards-Related Activities in the Area of Occupational Safety and Health"
Then scroll down to “International Classification of Radiographs of the Pneumoconioses” to order

During the transition from the 1980 to the 2000 edition of the ILO Classification, readers have asked about the use of different available sets of standard radiographs in classifying films under the current 2000 revision of the Classification.

Two issues have arisen:

1) The ILO now offers two distinct sets of the standard films, the “Complete Set” consisting of 22 radiographs, and the “Quad Set” consisting of 14 radiographs. Although the two sets are generally comparable, international trials have demonstrated some tendency for film classifications to vary, depending on the set of radiographs used. Thus, for the purposes of classifications under the NIOSH Coal Workers’ X-ray Surveillance Program, use of the “Complete Set” is preferred. Readers should consult with the responsible parties regarding this issue when they perform classifications for other purposes, such as research studies, medical surveillance programs, or clinical or medical-legal evaluations.

NIOSH B Reader Certification Program

B Reader Information for Medical Professionals

Ethical Considerations for B Readers

NIOSH Certified B Readers List

On This Page...

B Reader Examination

New ILO Revisions

Pre-Examination Preparation

Digital Radiography

Roentgenographic Interpretation Form

More Information

Related NIOSH Topics:

Occupational Respiratory Disease Surveillance

Coal Workers' Health Surveillance Program

2) In order to preserve continuity and consistency in the classifications, the images used in reproducing the 2000 version of the standard radiographs are identical to those used for the 1980 set of standard radiographs, aside from one image which demonstrates pleural abnormalities. The ILO did endeavor to improve image quality in the 2000 set by utilizing advanced computer image techniques. The NIOSH Coal Workers' X-ray Surveillance Program requires that readers submit classifications adhering to the 2000 Revised Edition of the Guidelines for the Use of the ILO International Classification of Radiographs of Pneumoconiosis. The sets of standard images used in the 2000 and 1980 Classifications are nearly identical, and thus it is the individual reader's choice which of these two sets of standard radiographs to use after that time. However, because the quality of the 2000 standard radiographs has been enhanced by the ILO, NIOSH recommends that readers consider using these current standard radiographs for classifying films for NIOSH programs and studies.

Pre-Examination Preparation

NIOSH strongly recommends some pre-test preparation for examination participants to assure familiarity with the ILO Classification System and associated Roentgenographic Interpretation Form. Pre-test preparation is extremely important because anyone who fails the examination must wait six months before re-testing. The examination is difficult and consistently demonstrates a 50/50 pass/fail rate.

Pre-test preparation is offered in the form of (1) the NIOSH Self-Study Syllabus which is available through ALOSH and developed specifically for this purpose; and/or (2) attendance at the American College of Radiology (ACR) Symposium on Radiology of the Pneumoconioses.

The Syllabus is available by mail in the United States on a first-come, first-served basis from ALOSH prior to scheduled testing. Additionally, the Syllabus may be used on-site by anyone interested in coming to Morgantown to study prior to taking the examination. The Syllabus can also be utilized at 9 other stationary locations across the country and 18 international sites. To request the syllabus, contact the CWHSP at (888) 480-4042.

The American College of Radiology (ACR) Symposium on Radiology of the Pneumoconioses is usually held every 2-3 years. The last Symposium was held during March 2004, in McLean, Virginia. You can contact the ACR for further details (800) 227-5463 ext. 4245.

Digital Radiography

In light of the recent technological advances in radiology, particularly in the area of digital radiology, many B Readers have inquired about the use of digital radiography in the classification of pneumoconioses. Questions have focused on the use of either 'soft copy' images that can be read on a monitor or 'hard copy' digital images that can be printed on film like traditional film-screen radiography (FSR). To comply with regulatory requirements under 42CFR Part 37, B Readers must continue to use standard film screen radiographs when classifying chest radiographs for the Coal Workers' X-Ray Surveillance Program. The regulation specifies the use of film no less than 14 by 17 inches, and the use of a diagnostic radiograph machine having a rotating anode tube with a maximum of a 2 mm. source.

In addition, the guidelines for use of the ILO International Classification of Radiographs of Pneumoconioses prescribe side-by-side viewing of subject and standard radiographs, and state that the standard films take precedence in defining profusion categories. Thus, until provisions for use of digital images have been specified, readers using the ILO Classification

for all purposes should continue to use traditional film screen radiographs and standards.

Roentgenographic Interpretation Form

Roentgenographic Interpretation Form
PDF only 115 KB (2 pages)
(OMB 0920-0020) (CDC/NIOSH 2.8) (October 2003)
This form must be completed by the A or B Reader that interprets a chest radiograph for NIOSH as part of the Coal Workers' X-ray Surveillance Program. Print/Copy as a double-sided form.

More Information

For more information about NIOSH B Reader certification, write or telephone--

ALOSH/NIOSH
Surveillance Branch
Coal Workers' Health Surveillance Activity
P.O. Box 4258
Morgantown, WV 26504
(888) 480-4042

◀ NIOSH B Reader Certification Program Ethical Considerations for B Readers ▶

NIOSH Home | NIOSH Search | Site Index | Topic List | Contact Us

NIOSH Safety and Health Topic:

Chest Radiography

Ethical Considerations for B Readers

The B Reader Code of Ethics is intended to assist B Readers in recognizing and maintaining a high level of ethical conduct. The outcome of chest radiograph classification can have important medical, legal, and social implications. It is critical that B Readers perform chest radiograph classifications properly and with integrity. This code, modeled after those of the American Medical Association and the American College of Radiology, is a framework to help B Readers achieve this goal.

B Reader Code of Ethics

The B reader's primary commitment is to serve the welfare and best interests of patients, workers, and society by striving to classify chest radiographs as accurately as possible.

B Readers shall uphold the standards of professionalism, be honest and objective in all professional interactions, and strive to report individuals or enterprises that they know to be deficient in character or competence, or engaging in fraud or deception, to appropriate entities.

B Readers shall recognize the limitations of chest radiograph classifications, and shall not make clinical diagnoses based on chest radiograph classification alone.

When a contemporary chest radiograph is classified, the B-reader or sponsoring organization must assure to the extent feasible that the patient or worker is promptly notified of all clinically important findings.

B Readers shall respect the law; the rights of patients, other health professionals, and clients; and shall safeguard medical information and other confidences within the constraints of the law.

B Readers shall continue to study and apply advances or changes to the International Labour Office International Classification of Radiographs of Pneumoconioses as specified by the National Institute for Occupational Safety and Health, B Reader Certification Program.

In providing expert medical testimony, B Readers should ensure that the testimony provided is unbiased, medically and scientifically correct, and clinically accurate.

B Readers shall recognize and disclose any conflicts of interest in the outcome of a chest radiograph classification. B Readers shall not accept compensation that is contingent upon the findings of their chest radiograph classifications or the outcome of compensation proceedings or litigation for which they undertake readings.

B Readers shall not advertise or publicize themselves through any medium or forum of public

Chest Radiography (Draft for discussion)

Normal Chest Radiograph

Topic Index:

Evaluating Occupational Lung Disorders

History of Radiograph Reading

ILO Classification

Applications for Chest Radiography in Occupational Health

Issues in Radiographic Interpretation

Recommendations for Applying the ILO International Classification of Radiographs of Pneumoconioses

Resources

communication in an untruthful, misleading, or deceptive manner.

B readers shall promptly report to the National Institute for Occupational Safety and Health, B Reader Certification Program any revocation or suspension of a medical license, voluntary relinquishment of a medical license or conversion to inactive status, or the voluntary surrender of a medical license while under investigation.

◀ B Reader Information for Medical Professionals

NIOSH Certified B Readers List ▶

NIOSH B Reader Certification Program

B Reader Information for Medical Professionals

▸ Ethical Considerations for B Readers

NIOSH Certified B Readers List

Related NIOSH Topics:

Occupational Respiratory Disease Surveillance

Coal Workers' Health Surveillance Program

NIOSH Safety and Health Topic:

Chest Radiography

NIOSH Certified B Readers List

This list will be updated automatically as Readers become certified and others drop off. Please note that the B Reader certification issued by NIOSH is national/international. Listing by state/country of residence here does not imply medical licensure. Medical licensure is a state/country function.

Use this search form to select the criteria for your search. Leaving all search fields blank will produce a complete list of Certified B readers.

Listed by State/Country of Residence

Last Name	
State	
Country	
Sort by	Reader's Name
Format	Table

Search - View List

Ethical Considerations for B Readers

Chest Radiography (Draft for discussion)

Normal Chest Radiograph

Topic Index:

Evaluating Occupational Lung Disorders

History of Radiograph Reading

ILO Classification

Applications for Chest Radiography in Occupational Health

Issues in Radiographic Interpretation

Recommendations for Applying the ILO International Classification of Radiographs of Pneumoconioses

Resources

NIOSH B Reader Certification Program

B Reader Information for Medical Professionals

Ethical Considerations for B Readers

NIOSH Certified B Readers List

Related NIOSH Topics:

Occupational Respiratory Disease Surveillance

Coal Workers' Health Surveillance Program

NIOSH Home | NIOSH Search | Site Index | Topic List | Contact Us

NIOSH Safety and Health Topic:

Chest Radiography

History of Radiograph Reading

> X-rays are similar to light. They travel in straight lines with a speed of 300,000 km per second. They blacken photographic film and cause certain crystalline materials to fluoresce. They tend to scatter when interacting with matter. They are composed of myriads of discrete bundles of energy, called photons. However, unlike light, whose photons contain only a small amount (a few electron-volts) of energy, x-rays are very energetic (tens of thousands of election-volts per photon). This difference causes x-rays to exhibit a number of distinct properties.
>
> X-rays have the ability to penetrate matter, the fraction of radiation either transmitted or absorbed by an object being dependent on (a) the object's density and thickness, (b) the object's elemental composition, and (c) the radiation's energy. This differential transmission and absorption of x-rays causes them, after passing through an object, to bear an image of the object's internal structure. Such an image can be converted to a visible image by means of an appropriate photographic film or fluorescent screen. (Morgan 1986)

The radiograph was discovered in 1895 by Wilhelm Conrad Roentgen. Roentgen's discovery led to a burst of scientific activity. By the turn of the century, radiographic equipment was in active clinical use all over the world. The widespread acceptance of radiological methods in medicine stems from the wealth of diagnostic information these methods provide. The chest radiograph in particular has become an essential element in medical diagnosis and an epidemiologic tool in the study of dust-related occupational disease. First developed to detect pulmonary tuberculosis, chest radiography applications have since evolved into: medical diagnosis, research and population surveillance, worker health monitoring, government program eligibility, compensation settings, and many other uses. (Morgan 1986)

References

Morgan RH. Radiology. In: Merchant JA, ed. *Occupational Respiratory Diseases.* (NIOSH Publication No. 86-102), 1986.

◀ Evaluating Occupational Lung Disorders

ILO Classification ▶

Chest Radiography

Normal Chest Radiograph

Topic Index:

Medical Professionals

Ethical Considerations for B Readers

NIOSH Certified B Readers List

NIOSH Home | NIOSH Search | Site Index | Topic List | Contact Us

NIOSH Safety and Health Topic:

Chest Radiography

ILO Classification

History

The International Labour Organization is a specialized agency of the United Nations that seeks the promotion of social justice and internationally recognized human and labor rights. The Organization formulates international labor standards in the form of Conventions and Recommendations setting minimum standards of basic labor rights: freedom of association, the right to organize, collective bargaining, abolition of forced labor, equality of opportunity and treatment, and other standards regulating conditions across the entire spectrum of work related issues. The International Labour Office (ILO) is the Organization's research body and publishing house (ILO 2002).

A series of guidelines on how to classify chest radiographs for persons with pneumoconioses has been published by the ILO since 1950. The goal of this process was to describe and codify the radiographic abnormalities of the pneumoconioses in a simple, reproducible manner. The most recent edition was revised in 2000 and is described in the 2002 ILO publication *Guidelines for the Use of the ILO International Classification of Radiographs of Pneumoconioses* (ILO 2002).

Classification Scheme

The Classification system includes the Guidelines and two sets of standard films. The standard films represent different types and severity of abnormalities and are used for comparison to subject films during the classification process. The system is oriented towards describing the nature and extent of features associated with the different pneumoconioses, including coal workers' pneumoconiosis, silicosis, and asbestosis. It deals with parenchymal abnormalities (small and large opacities), pleural changes, and other features associated, or sometimes confused, with occupational lung disease.

In the present manifestation of the ILO system, the reader is first asked to grade film quality. They are then asked to categorize small opacities according to shape and size. The size of small round opacities is characterized as p (up to 1.5 mm), q (1.5-3 mm), or r (3-10 mm). Irregular small opacities are classified by width as s, t, or u (same sizes as for small rounded opacities). Profusion (frequency) of small opacities is classified on a 4-point major category scale (0 – 3), with each major category divided into three, giving a 12-point scale between 0/- and 3/+. Large opacities are defined as any opacity greater than 1 cm that is present in a film. Large opacities are classified as category A (for one or more large opacities not exceeding a combined diameter of 5 cm), category B (large opacities with combined diameter greater than 5 cm but does not exceed the equivalent of the right upper zone), or category C (bigger than B). Pleural abnormalities are also assessed with respect to location, width, extent, and degree of calcification. Finally, other abnormal features of the chest radiograph can be commented upon (ILO 2002). All of these abnormalities are well illustrated and described in the Guidelines for the Use of the ILO International Classification of Radiographs of Pneumoconioses. To see how a classification is recorded, follow this link to the

Chest Radiography (Draft for discussion)

Normal Chest Radiograph

Topic Index:

Roentgenographic Interpretation Form used by the NIOSH Coal Workers' X-Ray Surveillance Program.

Examples of Normal and Abnormal Radiographs

Normal Radiograph	Radiograph showing Simple Coal Workers' Pneumoconiosis	Radiograph showing Progressive Massive Fibrosis
Normal Radiograph	Simple Coal Workers' Pneumoconiosis	Progressive Massive Fibrosis

References

International Labour Office (ILO). *Guidelines for the Use of the ILO International Classification of Radiographs of Pneumoconioses, Revised Edition 2000* (Occupational Safety and Health Series, No. 22). International Labour Office: Geneva, 2002.

◀ History of Radiograph Reading Applications for Chest Radiography in Occupational Health ▶

NIOSH Home | NIOSH Search | Site Index | Topic List | Contact Us

Certification Program

B Reader Information for Medical Professionals

Ethical Considerations for B Readers

NIOSH Certified B Readers List

NIOSH Safety and Health Topic:

Chest Radiography

Applications for Chest Radiography in Occupational Health

Medical Diagnosis

Medical diagnosis is defined as the determination of the nature of a case of disease. Usually, the patient is symptomatic and seeks care from their primary care physician. Chest radiography is a common medical test for evaluating respiratory disease. In occupational disease, the worker develops symptoms and seeks care with their physician. This is contrast to worker health monitoring programs where workers receive medical testing routinely for the purpose of detecting abnormalities and are then referred to a physician for further evaluation. For instance, chest radiography when used for medical diagnosis in miners is often the result of the miner actively seeking medical treatment and evaluation, rather than a passive or retrospective system used in epidemiological research (Wagner 1993). Medical diagnosis of pneumoconiosis is not always done by the radiograph alone—it is often done in conjunction with a comprehensive medical history, physical examination, newer imaging techniques, physiologic evaluation and sometimes more invasive procedures such as a biopsy. The ultimate objective of a medical evaluation is to learn from all of the information that is available to diagnose and treat that particular person. Medical diagnosis can also be used to help determine disability, which will be further discussed under Government Program Eligibility

Research and Population Surveillance

Epidemiology research is defined as the study of the distribution and determinants of disease frequency in human populations. The primary use for radiographs in epidemiological studies of the pneumoconioses has been to determine indices of prevalence and inceidence of various medical endpoints for use in assessing in exposure-response of dust-exposed workers. An example of epidemiology research being put into practice was the determination of the current federal dust standard. The current federal dust standard is based on research done in British mines that was then applied to mines in the United States (Wagner 1993).

The general premise of surveillance is to collect information, which can later be analyzed for trends, prevalence of disease in workers in specific worksites, and the development of interventions. Surveillance data can be used to target interventions in order to reduce the disease burden and assess the effectiveness of disease prevention activities. The effectiveness and practicality of a surveillance system depends on program participation, adequacy of data collection, analysis, dissemination, and effectiveness of interventions. Over time the practice of surveillance has progressed from passive documentation of disease to active analysis of data in order to generate an appropriate public health response (Wagner 1993).

An example of surveillance, as it relates to the coal mining industry, is the National Institute for Occupational Safety and Health (NIOSH) Coal Workers' X-Ray Surveillance Program. This surveillance program, which started in 1970, has showed a steady decline in the number of cases

Chest Radiography

Normal Chest Radiograph

Topic Index:

Evaluating Occupational Lung Disorders

History of Radiograph Reading

ILO Classification

▸Applications for Chest Radiography in Occupational Health

Issues in Radiographic Interpretation

Recommended Practices for Reliable Radiographic Classification by B Readers

Resources

NIOSH B Reader Certification Program

B Reader Information for

of coal workers' pneumoconiosis. That observation is just one of many that can be found when doing surveillance. Also, surveillance can be used to identify worker sites (mines or plants) that have increased rates of disease or specific populations (counties or job classifications) that may be developing disease at a more rapid rate than other populations.

Worker Health Monitoring

Worker health monitoring programs provide routine medical testing to exposed workers for the purpose of detecting abnormalities. They are then referred to a physician for further evaluation. There are often worker health monitoring components within surveillance programs. The primary purpose of any monitoring program is to detect any abnormality in an individual as early as possible to provide some intervention while a favorable outcome is still achievable. Chest radiography is often used as part of monitoring programs for dust-exposed workers. While radiographs are useful in the detection of coal workers' pneumoconiosis, they are not useful for detecting some other dust-related lung diseases, such as chronic obstructive airways disease (COPD) (Wagner 1993). When the radiograph is abnormal, the workers are advised to follow up with their personal physicians for further testing. More information about abnormalities can be found under Medical Diagnosis.

Government Program Eligibility

Federal Black Lung Benefits, Workers' Compensation Benefits and the Energy Employees Occupational Illness Compensation Program are three federal programs that provide compensation for pneumoconiosis due to occupational dust exposure. Specific findings relevant to coal workers' pneumoconiosis must be established, before benefits are awarded. For legal purposes, diagnosis is contingent upon a chest radiograph, as well as other supporting examinations, such as a physical examination, spirometry, and other tests deemed necessary for an accurate diagnosis of coal workers' pneumoconiosis.

Black Lung Benefits Act (BLBA)

The BLBA was established in 1969, as part of the Federal Coal Mine Health and Safety Act. The BLBA is designed to provide compensation and/or medical treatments to miners who are disabled by pneumoconiosis or, upon their death, to their survivors. Pneumoconiosis by statute is defined as "a chronic dust disease of the lung and its sequelae, including respiratory and pulmonary impairments arising out of coal mine employment" (Richman 1993). BLBA compensation is a separate entity from Workers' Compensation and a person may qualify for BLBA and not Workers' Compensation or vice versa. The first step to qualify for benefits for black lung is to file a claim with the U.S. Department of Labor (DOL). Once the claim is received miners are given a pulmonary examination, at no cost to the miner. A complete pulmonary examination for black lung disease consists of a chest radiograph, breathing tests, and blood gas tests (20 CFR 725.406 (A) external link). Often, it is required that certified B Readers classify the radiographs for determination of benefits. More information on the BLBA can be found in the Best- Practices for Government Program Eligibility section of this Web site, as well Black Lung Benefits Home Page (external link).

Workers' Compensation Benefits

Workers' Compensation is intended to provide benefits for those injured or disabled on the worksite. Workers who have occupational lung disease due to dust exposure may qualify for Workers' Compensation but not Black Lung Benefits, and vice versa. All states have a Workers' Compensation office; however, benefits differ by state. A complete listing of state compensation offices can be found at State Workers' Compensation Programs (external link).

Medical Professionals

Ethical Considerations for B Readers

NIOSH Certified B Readers List

Energy Employees Occupational Illness Compensation Program

The Energy Employees Occupational Illness Compensation Program Act of 2000 provides compensation for employees or eligible survivors of employees of the Department of Energy, its predecessor agencies, and its contractors and subcontractors who became ill as a result of the work performed in the production and testing of nuclear weapons. Silicosis is a covered condition under the Act. Eligible employees are those who were exposed to silica for a total of at least 250 work days during the mining of tunnels at a Department of Energy facility located in Nevada or Alaska for tests or experiments related to an atomic weapon. Individuals with these exposures and seeking compensation should contact the Energy Employees Occupational Illness Compensation Program [EEOICPA Web site (external link)].

Compensation Settings

Classifications of radiographs are also used in court cases that involve compensation for occupationally acquired lung disease. The International Labour Organization (ILO) Classification system does not imply legal definitions of pneumoconioses for compensation purposes and does not set or imply a level at which compensation is payable (ILO 2000). Compensation proceedings utilize B Readers for testimonial purposes and expert advice. In these court cases, certified B Readers are asked to classify chest radiographs according to the ILO Classification system and to serve as expert witnesses to discuss their interpretations.

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External Link: http://www.dol.gov/dol/allcfr/Title_20/Part_725/toc.htm

Black Lung Benefits Program. Division of Coal Mine Workers' Compensation Program and District Offices, Department of Labor
External Link: http://www.dol.gov/esa/regs/compliance/owcp/bltable.htm

State Workers' Compensation Officials. US Department of Labor
External Link: http://www.dol.gov/esa/regs/compliance/owcp/wc.htm

International Labour Office (ILO). Guidelines for the Use of the ILO International Classification of Radiographs of Pneumoconioses, Revised Edition 2000 (Occupational Safety and Health Series, No. 22). International Labour Office: Geneva, 2002.

Energy Employees Occupational Illness Compensation Program Act of 2000, as described on the US Department of Labor compliance assistance web site.
External Link: http://www.dol.gov/esa/regs/compliance/owcp/ca_eeoic.htm

◀ ILO Classification

Issues in Radiographic Interpretation ▶

NIOSH Safety and Health Topic:

Chest Radiography

Issues in Radiographic Interpretation

Accuracy and Precision

As with all medical measurements and indices, radiographic interpretation is subject to issues of accuracy and precision. Accuracy is defined as the ability for a measurement to reflect the true underlying type and extent of abnormality, and is typically assessed by reference to some "gold standard." Precision, on the other hand, reflects the extent to which a measurement is consistent when assessed on different occasions. Both criteria are important – a measurement technique can be precise but inaccurate, or accurate and imprecise, but preferably should be both accurate and precise.

In radiographic interpretation accuracy and precision are obtained in different ways. Of the two, accuracy tends to be a bigger issue. However, since there is no method by which a gold standard evaluation can be obtained, ensuring accuracy is difficult. Conventionally, it is sought by careful training and re-training, and regular evaluation, such as through the B reader certification and re-certification examinations. Within particular applications, further measures can be employed, including quality control studies to assess similarity of readings with those by experts. These studies can be undertaken before, after, and during film reading exercises. They can be done with or without the readers being aware of being assessed, and including at minimum, feedback to readers, or at maximum, actions to remove outlying readers from the reading pool.

Precision is also improved by training and certification. However, it is typically attained through repeated readings, usually by employing different readers who read the films blind to other readers' classifications. When using multiple readings, however, it is important to understand the implications of procedures to obtain overall, summary readings from the separate classifications. For example, mandating that all readers agree (to some defined extent) on the classifications impinges on accuracy, in that such summary readings may tend to reflect those from the reader who tended to report the least amount of abnormality. Instead, adoption of a summary statistic that truly reflects the central tendency, such as the median reading, preserves accuracy while enhancing precision.

The extent to which readings need to be accurate and precise is not fixed, but depends on the application. In all applications, economic cost plays a role, since most attempts to enhance these criteria involve dedication of resources. Social cost plays a role too, in that some applications involve trade-offs between the needs and desires of parties with different interests, such as in worker health monitoring or compensation settings. In other applications, scientific considerations or health protection may be most important.

Further details on these aspects are given below and in the best practices sections dealing with

Chest Radiography (Draft for discussion)

Normal Chest Radiograph

Topic Index:

Evaluating Occupational Lung Disorders

History of Radiograph Reading

ILO Classification

Applications for Chest Radiography in Occupational Health

Issues in Radiographic Interpretation

Recommendations for Applying the ILO International Classification of Radiographs of Pneumoconioses

Resources

NIOSH B Reader

each application.

Inter- and Intra-Reader Variability

Description/History/Problems

Inter- and intra-reader variability in chest radiography has existed since chest radiography was first used to identify and classify pneumoconiosis (Fletcher 1949). Inter-reader variability occurs when readers disagree amongst themselves on a classification. Intra-reader variability occurs when a reader classifies a radiograph differently on different occasions. Reader variability prompted the International Labour Office (ILO) to develop the ILO Classification scheme for the pneumoconioses and has prompted its continued revision since then (Bohlig 1970). It was also a catalyst for development of the NIOSH B Reader Program.

Reader variability is probably inherent and unavoidable in radiograph classification for the pneumoconioses, but if excessive, is undesirable because it severely reduces the quality and usefulness of the data. Systematic reader differences can skew study results and also lead to misdiagnosis thereby impacting the eligibility for, and award of compensation. In a classic study, Garland says, “humans, even experts in a given field, exhibit enormous variations in the ability to be consistent with themselves and others equally competent in applying to mass-survey work… resulting in people being informed that their chests are free from disease when they are not and vice versa. This results in the false security on the one hand and needless alarm on the other.” (Parker 1989) Disagreement among readers involved in epidemiological or surveillance studies can usually be minimized using appropriate scientific techniques, but radiograph reading in compensation settings often results in polarized opinions that are extremely difficult to reconcile (Jacobsen 1991, Ducatman 1991).

In addition to readers systematically disagreeing with each other, it has been found that groups of readers in certain localities tend to exhibit their own reading tendencies. Such an effect was reported comparing certain British and U.S. readers (Reger 1973).

The persistence of reader differences despite intensive measures to assess and correct it is demonstrated by findings for British coal miners. The British National Coal Board had a rigorous checking process for both inter- and intra-reader variability that involved mixing in already classified radiographs into a group of current radiographs to determine if the readers achieved the same classification. They also employed the practice of sending the same radiograph to multiple readers. They found that even with rigorous methods they could not totally eliminate reader variability (Fay 1959, Hurley 1982).

Reader selection, multiple readers, panels, quality control/quality assurance, and calibration films are the main methods used to reduce reader variability.

How to Deal with Reader Variability

In order to minimize variability and have the highest quality classifications, individual readers should apply the ILO Classification system within the context of a process that uses additional measures to assure quality. These include selection of readers for mainstream reading tendencies, use of multiple readers, classification of quality control films to document and maintain accuracy and reproducibility of classifications, and blinding of readers to the circumstances under which radiographs were obtained.

Reader Selection

Readers should be both proficient and experienced in interpreting chest radiographs for the

Certification Program

B Reader Information for Medical Professionals

Ethical Considerations for B Readers

NIOSH Certified B Readers List

pneumoconioses. Ideally, they should be currently certified B Readers, have extensive experience in classifying radiographs of dust-exposed workers, and be representative of general reading practices among readers (i.e., they do not fall at either end of the extremes of the range of variability between readers).

Multiple Readers/Panels

Thus, multiple readings have been proposed as a means to increase the accuracy of the ensuing data. However, their use *per se* certainly does not guarantee unbiased findings if the pool of readers is skewed toward one or other extreme of reading levels. Moreover, methods of averaging results from multiple readings can actually introduce bias. For example, requiring complete consensus among the reader pool would tend to reduce the final determinations to those of the reader finding the least abnormality. Such determinations would not reflect those of most of the individual readers in the pool.

Despite the pitfalls that can unwittingly or otherwise impact multiple readings, they have found appropriate and useful application to increase precision in epidemiologic and surveillance applications. With suitable choice of readers (see above) and appropriate summary techniques to average the individual scores, and other considerations, multiple readings certainly provide a means to reduce the variability inherent in film reading (Jacobsen 1991).

The use of reader panels, in which groups of readers jointly classify radiographs and together come to a consensus or unanimous decision, is not usually recommended. Apart from the logistical difficulties of convening such panels, they may fail to represent the true range of opinions in the group. That is, the final determinations may reflect that of the most dominant or experienced reader in the group.

Regular Quality Control

In the context of film reading, quality control implies the use of some kind of special reading exercise in order to assess differences between readers and then to feed the information back to them with the expectation that the readers will modify their readings to bring them closer to the average tendency (improve accuracy). Quality control exercises can be undertaken prior to studies, providing the means to educate and train readers before a study starts and can be done during the course of a study so as to provide continuing feedback and maintenance of standards. Done at the end, they provide a final check on reader consistency.

One means of quality control depends solely upon comparison of certain radiograph films within the study, which are assessed by all readers and the differences between readers for the set compared. Quality control could also be undertaken using an external set of films specially classified by a panel of expert readers beforehand. This implies that this panel constitutes a ‘gold standard,’ although it has been stated that “there is no gold standard for B Reading in surveillance settings” (Ducatman 1988). Naturally, the validity of this approach depends on the selection of an appropriate set of quality control radiographs and the choice of expert readers.

Based on documented experience, quality control exercises should not be expected to eliminate inter-reader variation. As noted above, even with experienced, highly motivated, and well-intentioned readers, differences may persist even in the presence of active quality control programs. In other circumstances, quality control efforts may provide misleading reassurances of compliance. For example, readers could change their reading habits during the quality control exercise compared to their normal reading habits. This implies that concurrent monitoring of reading levels undertaken without knowledge of the reader is desirable.

Concurrent monitoring of reading levels can be accomplished by adding quality control ("calibration") films to film packets without the reader being aware of which films comprise the

evaluation set and which films are unknowns. For example, a National Institutes of Health-sponsored workshop suggested including chest films of unexposed workers in epidemiologic studies for purposes of control [Weill 1975]. Optimally, quality control films should include a range of abnormality levels and types previously classified by an expert panel of readers. There are many benefits to this approach. First, since the reader is unaware of which are the quality control films, yet knows that they exist within the study, the reader is under pressure to conform to standard reading practices. Second, when the reading is finished the results for the quality control radiographs are used to inform the study director of the accuracy and precision of the reader's readings. Based on this it may be necessary to disregard or lower the weight of that evidence or to apply some correction factor based on how the reader's classifications compare with those of the expert panel. Results of quality control classifications can also be used to provide feedback to readers to maintain and improve readers' performance [Sheers 1978]. Finally, this approach eliminates the defects in other quality control approaches associated with the reader's cognizance of being evaluated. Although this approach to quality control cannot be expected to eliminate all variation between readers, it should result in the elimination of excesses.

Bias from Knowledge of Exposures and Other Factors

Overall bias can occur when readers know the nature of the workplace exposure of the radiographs being classified. Knowledge of exposures can bias readers to recording more or fewer abnormalities or preferentially selecting certain types of abnormality (e.g., rounded opacities for silica-exposed workers versus irregular for asbestos-exposed workers). Blinding readers (meaning hiding the work history from the reader) allows the classification to be made without preconceived ideas. In order to minimize such bias, all epidemiologic studies should try to remove any identifying information, such as age, occupation, work site, and medical history from the radiograph before it is sent for classification. Among sequential radiographs representing possible temporal trends in disease development or progression, it has been shown that knowledge of the time order influenced a reader's classifications (Reger 1974). Ideally, the reader should know nothing of the source of the radiographs or the nature of the overall study.

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◀ Applications for Chest Radiography in Occupational Health

Recommendations for Applying the ILO International Classification of Radiographs of Pneumoconioses ▶

NIOSH Home | NIOSH Search | Site Index | Topic List | Contact Us

NIOSH Safety and Health Topic:

Chest Radiography

Recommendations for Applying the International Labour Office (ILO) International Classification of Radiographs of Pneumoconioses in Medical Diagnosis, Research and Population Surveillance, Worker Health Monitoring, Government Program Eligibility, and Compensation Settings

NOTICE: NIOSH Seeking Public Comment

The National Institute for Occupational Safety and Health is using the issuance of the new International Labour Office (ILO) Classification of Radiographs as an opportunity to expand its Web site on the B Reader Program and use of the ILO system. NIOSH-certified B readers use the internationally-recognized ILO system to classify chest radiographs for the presence and severity of pulmonary parenchymal and pleural changes potentially caused by exposure to dusts such as asbestos, silica, and coal mine dust. The revised program Web site provides more information about radiographic reading and the ILO system including recommendations or "best practices" for use of the ILO system in different settings.

Below is a draft of "Recommendations for Applying the International Labour Office (ILO) International Classification of Radiographs of Pneumoconioses in Medical Diagnosis, Research and Population Surveillance, Worker Health Monitoring, Government Program Eligibility, and Compensation Settings." We are seeking public comment for this document. Please review it and submit your comments by **October 15, 2005**, to CWHSP@cdc.gov. If you would prefer to have a hard copy rather than electronic, please let us know, and we will be happy to fax or mail one to you.

Thank you in advance for your input. It is important to us that we consider many different viewpoints in this document. Also, we are interested in your feedback on the whole Web site. Please feel free to send any comments or suggestions to the same address.

Chest Radiography (Draft for discussion)

Normal Chest Radiograph

Topic Index:

Draft proposal for public comment. The following should not be considered NIOSH policy but reflect preliminary efforts to disseminate guidance on best reading practices. The final text will modified based on input received from stakeholders.

This draft document is also available as a PDF that can be used to specify page and line numbers when submitting comments to NIOSH.

recommendations.pdf 17 pages, 230kb 

The International Labour Office (ILO) International Classification of Radiographs of Pneumoconioses was developed primarily for use in epidemiological research. In this classification system, parenchymal lung abnormalities on chest radiographs are identified and radiographic severity is classified on a 12-point scale ranging from 0/- to 3/+ by comparing the radiographs to ILO standard films. Pleural abnormalities are also identified and described. Although the ILO system was developed primarily for use in research, the standardized descriptions of chest radiographs used in the system, and even the scoring system itself, have been applied in a wide range of settings. In some non-research settings, how or even whether ILO Classification should be applied has been controversial. In this document, guidance is provided for the roles of ILO Classification and NIOSH-certified B Readers performing ILO Classification in several important settings. Setting-specific suggestions for how ILO classifications should be performed are also provided.

A “Summary of Recommendations” is provided at the beginning of each section. Each addresses several critical issues. These concern the desirability of 1) using the ILO Classification for the specific purpose, 2) employing readers certified by the National Institute for Occupational Safety and Health (NIOSH) B Reader Program, 3) using single or multiple readings of chest radiographs, 4) employing “blind” reading to avoid potential biases from knowing employment and other details of the cases being classified, 5) using classification of quality control films to assess readers’ tendencies to under- or over-classify films.

Recommended Application of the ILO Classification System in Medical Diagnosis

Draft proposal for public comment. The following should not be considered NIOSH policy but reflect preliminary efforts to disseminate guidance on best reading practices. The final text will modified based on input received from stakeholders.

The chest radiograph plays a key role in clinical diagnosis of pneumoconiotic and other pulmonary diseases.

Health

Issues in Radiographic Interpretation

Recommendations for Applying the ILO International Classification of Radiographs of Pneumoconioses

Resources

NIOSH B Reader Certification Program

B Reader Information for Medical Professionals

Ethical Considerations for B Readers

NIOSH Certified B Readers List

On This Page...

Medical Diagnosis

Research and Population Surveillance

Worker Health Monitoring

Government Program Eligibility

Compensation Settings

Best Technical Practices

Radiographic abnormalities can indicate the presence and extent of pulmonary disease. Radiographic findings alone are generally insufficient for diagnosis of pulmonary diseases. Diagnosis generally requires consideration of additional information such as clinical history, physical examination, and other types of medical tests. Still, radiographic differential diagnosis can establish a range of diagnostic possibilities and is often a critical part of disease diagnosis. The outcome sought from disease diagnosis is to prescribe appropriate treatment that alleviates disease morbidity and mortality.

Summary of Recommendations

ILO Classification:	No (but principles used in system can be applied)
B Reader certification:	No (but the knowledge is useful in demonstrating competence)
Multiple readings:	Single (unless further opinion necessary)
Blind reading:	Not necessary
Quality control films:	Not necessary

Symptomatic dust-exposed workers should see their physician right away

Workers who suffer dust exposure at work or who have a history of dust exposure and have chest symptoms, such as shortness of breath, cough, or any other respiratory health concerns, should ask their doctor about these symptoms right away.

Workers exposed to either coal mine dust or other kinds of dusts, such as asbestos or silica dust, and have no regular doctor can find a doctor skilled in occupational diseases by looking at the Association of Occupational and Environmental Clinics (AOEC) Web site (external link). The AOEC provides a list of occupational and environmental clinics and resources by state. Other types of doctors, such as those specializing in Pulmonary Diseases, are also able to provide expert diagnosis and treatment.

Coal miners who do not have a regular doctor can find a doctor who knows about mining-related health problems at one of the U.S. Government–supported Black Lung Clinics. These clinics typically offer benefits such as counseling, testing, and treatment. They provide services such as chest radiographs, pulmonary function testing, other laboratory tests, and education about respiratory diseases for miners and their families. Active, inactive, and retired coal miners who suffer from chronic respiratory disease are eligible for these services. Services vary from clinic to clinic, so check with the nearest Black Lung Clinic (external link) for specifics.

Further information

The role of radiography in diagnosis

Among those with a history of workplace dust exposure, chest radiographs are part of medical testing for lung diseases like coal workers' pneumoconiosis, silicosis, and asbestosis (that is, the pneumoconioses). The goal of medical diagnosis is for the physician to accurately and quickly identify patients' diseases, so that appropriate and timely treatment can be started.

Radiography is only one component of medical testing for clinical diagnosis

No medical test, including chest radiography, is perfect. Chest radiography can miss some cases of dust-induced lung disease and falsely identify others. In addition, workplace dusts can cause medical outcomes that often cannot be diagnosed based on chest radiograph alone. For instance, inhalation of coal mine dust is associated not only with coal workers' pneumoconiosis but also with chronic obstructive lung diseases, such as chronic bronchitis and emphysema. In order to be accurate and comprehensive in their diagnoses, physicians must synthesize information from patients' occupational and medical histories (including dust exposures), symptoms, physical examinations, and medical testing. The type of medical testing depends on the suspected disease(s) and may include radiography, lung function testing, laboratory tests, and, in some cases, invasive testing such as lung biopsy. The American Thoracic Society (ATS) and other medical organizations publish official guidelines for diagnosis and management of respiratory diseases such as asbestosis. These guidelines emphasize the importance of using multiple diagnostic modalities. When available and appropriate, these guidelines should be used for the suspected disease [ATS 2004].

Single radiograph readings are appropriate

For medical diagnosis purposes, single radiograph readings are appropriate and do not need to be done as formal International Labour Office (ILO) classifications or by a certified B Reader. However, principles underlying the ILO Classification scheme for the pneumoconioses are applicable to clinical radiographic interpretation and can be useful in describing abnormalities, if present. Additional readings by a specialist or expert may be helpful in order to confirm a diagnosis in some situations. Although not needed for clinical diagnosis, ILO classification may eventually be required for participation in Federal or State compensation systems (see sections below on "Government Program Eligibility" and "Compensation Settings").

Timely disclosure of results, appropriate follow-up, and patient education are essential

Once the diagnosis is made, physicians should disclose results to the patient in a timely manner, provide appropriate medical follow-up, and educate patients about their illnesses and approaches to avoid or minimize further exposure to workplace dusts and other harmful exposures, e.g., tobacco smoke. Further exposure must be reduced to prevent progression of the disease, and appropriate treatment can minimize the impact of established disease.

Physicians must follow state reporting requirements

Physicians should be mindful that recognition of occupational lung disease can provide an opportunity for

preventive interventions not only for the affected worker but also for the associated workplace, process, agent, or industry. Physicians and other health care providers are encouraged, and in some states required, to notify their State of diagnosed or suspected cases of occupational pneumoconioses, including silicosis and asbestosis. A chest radiograph classified or otherwise interpreted as consistent with the reportable disease is often considered sufficient evidence to require reporting. If physicians are not already aware of their State reporting requirements, they should contact their state to be apprised of any reporting requirements for which they may be responsible. Contacts for State Public Health Departments can be found on the Association for State and Territorial Health Officials (ASTHO) Web site (external link).

Physicians should also inform their patients about filing deadlines for state Workers' Compensation and Federal Black Lung benefits in order to preserve eligibility. The patient should be advised that there are often time limits that apply to how long individuals have to make a claim after they are diagnosed with a compensable disease.

References

Black Lung Clinics Program. Bureau of Primary Health Care, Health Resources and Services Administration
External Link: http://bphc.hrsa.gov/blacklung/default.htm

Association of Occupational and Environmental Clinics
External Link: http://www.aoec.org/

American Thoracic Society. Diagnosis and Initial Management of Nonmalignant Diseases Related to Asbestos. *Am J Respir Crit Care Med* 2004;170:691-715.

Association for State and Territorial Health Officials
External Link: http://www.astho.org/

Recommended Application of the ILO Classification System in Research and Population Surveillance

Draft proposal for public comment. The following should not be considered NIOSH policy but reflect preliminary efforts to disseminate guidance on best reading practices. The final text will modified based on input received from stakeholders.

Classifications undertaken for research and population surveillance of the pneumoconioses need to be accurate (valid) and precise (reliable). For example, reliably establishing temporal or geographic trends in disease prevalence or incidence, disease relationships with occupation and industry, and exposure-response relationships

are all objectives that require consistent, reproducible scoring of films in order for the underlying effects to emerge. Thus, in these settings, accurately and precisely scoring films in relation to the International Labour Office (ILO) standard films is a critical goal and great care must be taken to attain it.

Summary of Recommendations

ILO Classification:	Yes
B Reader certification:	Yes
Multiple readings:	Yes
Blind reading:	Yes
Quality control films:	Desirable

Further information

The role of radiography in epidemiology and related research

The ILO International Classification of Radiographs of Pneumoconioses was designed as a mechanism for assessing occupational lung disease. It is based on classifying the degree of parenchymal lung abnormality on an unknown film on a 12-point scale ranging from 0/- to 3/+ by comparing it to ILO standard films [ILO 2000]. Pleural abnormalities are also identified and classified. Since its inception, ILO Classification has become a critical and necessary tool for investigation of the pneumoconioses. The validity of ILO Classification has been repeatedly demonstrated in many settings and industries. For example, classifications of radiographs of coal miners show clear correlations with dust exposure, lung dust burden, lung pathology, and mortality [Attfield 1992, Ruckley 1984, Miller 1985]. Elsewhere, classifications of radiographs of patients with asbestos-related lung disease were shown to be correlated with lung function [Cotes 1988]. A useful summary of criteria to consider for epidemiologic purposes is given by Mulloy et al. [1993].

Issues of reader variability

It is well known that variation exists not only from reader to reader (inter-reader variation), but also between readings by the same reader (intra-reader variation). Variation has been seen to persist despite careful training and extensive quality control [Fay 1959, Hurley 1982]. To reduce the effect of variation between readers in epidemiologic studies in order to derive the most precise data, it is recommended that at least two, but preferably more, readers each classify all radiographs independently [ILO 2000]. Use of panels reading films simultaneously is not recommended. Rather, readers should classify the radiographs alone and blind to the interpretations of other readers and to any information on the individual. These individual readings can be combined into a single summary classification. Summarization methods that represent the middle of the distribution of readings, such as use of median classifications, are preferable. Summarization methods that do not reflect the central tendency of the range of readings by their nature result in biased determinations and should be avoided**.**

Select trained and experienced readers

Readers for epidemiologic studies should be selected to be representative of general reading practices: that is, they should not fall at the extremes of the range of variability between readers. The readers should be informed about and assessed for inter- and intra-reader variability.

A pilot trial and use of quality control film interpretation may be useful to assess the extent of inter-reader variation. Feedback should be provided to give passive encouragement to those in the extremes to moderate their readings. Alternatively, an active procedure of selecting readers based on their standing with respect to the others can be adopted.

Quality control

As noted above, initial and subsequent interval re-assessment of readers' performance in scoring quality control films is useful in documenting systematic differences between readers. Over time, variation between repeated classifications of the same films can also be used to assess whether "drift" in readers' scoring is occurring. Providing feedback to readers based on quality control evaluations is a useful strategy for narrowing the distribution and maintaining reproducibility of classifications relative to ILO standard films.

Quality control can be done simultaneously with interpretation of unknown films by placing unidentified quality control ("calibration") films with a previously established array of parenchymal and/or pleural findings within the set of unknown films being evaluated. An advantage to this approach is that it provides the most realistic assessment of how readers classify unknown films. Providing feedback comparing the reader's classification of these films to the previously-established classifications has been used to maintain and improve reader performance [Sheers 1978]. A National Institutes of Health-sponsored workshop suggested including chest films of unexposed workers in epidemiologic studies for purposes of control [Weill 1975].

Classify films blind to medical and exposure information

When classifying radiographs for epidemiologic purposes, it is essential to be aware that knowledge of supplementary details specific to individuals can introduce bias into results. This includes medical or exposure information and other readers' interpretations. [ILO 2000] To avoid the effects of any temporal reader drift, films collected over the course of a study can be allocated to readers in batches that are random with respect to time and other study characteristics.

References

International Labour Office (ILO). Guidelines for the Use of the ILO International Classification of Radiographs of Pneumoconioses, Revised Edition 2000 (Occupational Safety and Health Series, No. 22). International Labour

Office: Geneva, 2002.

Attfield MD, Morring K. An investigation into the relationship between coal workers' pneumoconiosis and dust exposure in U.S. coal miners. *Am Ind Hyg Assoc J* 1992; 53:486-92.

Ruckley VA, Fernie JM, Chapman JS, et al. Comparison of radiographic appearance with associated pathology and lung dust content in a group of coalworkers. *Br J Ind Med* 1984; 41:459-67.

Miller BG, Jacobsen M. Dust exposure, pneumoconiosis, and mortality of coal miners. *Br J Ind Med* 1985; 42:723-33.

Cotes JE, King B. Relationship of lung function to radiographic reading (ILO) in patients with asbestos related lung disease. *Thorax* 1988; 43(10):777-83.

Mulloy KB, Coultas DB, Samet JM. Use of chest radiographs in epidemiological investigations of pneumoconioses. *Br J Ind Med* 1993; 50(3):273-5.

Fay JWJ, Rae S. The Pneumoconiosis Field Research of the National Coal Board. *Ann Occup Hyg* 1959; 1:149-61.

Hurley JF, Burns J, Copland L, et al. Coalworkers' simple pneumoconiosis and exposure to dust at 10 British coalmines. *Br J Ind Med* 1982; 39:120-7.

Sheers G, Rossiter CE, Gilson JC, Mackenzie FAF. UK naval dockyards asbestos study: radiological methods in the surveillance of workers exposed to asbestos. *Br J Ind Med* 1978; 35:195-203.

Weill H, Jones R. The chest roentgenogram as an epidemiologic tool. Report of a workshop. *Arch Environ Health* 1975; 30:435-9.

Recommended Application of the ILO Classification System in Worker Health Monitoring

Draft proposal for public comment. The following should not be considered NIOSH policy but reflect preliminary efforts to disseminate guidance on best reading practices. The final text will modified based on input received from stakeholders.

Worker health monitoring is an important tool for preventing disease in occupational settings. For the purposes of this document, it refers to the detection of pneumoconioses in dust-exposed individuals through periodic chest radiography. Positive findings can result in both medical evaluation of the affected worker and workplace interventions that prevent further disease development in both the affected individual and similarly exposed co-

workers. Worker health monitoring is considered a secondary prevention measure, intended to provide a backup when primary prevention (e.g., dust exposure monitoring and control) measures fail.

Summary of Recommendations

ILO Classification:	Yes
B Reader certification:	Yes
Multiple readings:	Desirable for positive films and a small percentage of negative films
Blind reading:	Not necessary
Quality control films:	Desirable

Further information

The role of radiography in monitoring

There is a long history of using chest radiographs in worker health monitoring for the pneumoconioses. Two examples are the Coal Workers' X-ray Surveillance Program (CWXSP), which is a federal program for the detection of coal workers' pneumoconiosis (CWP) in currently-working underground coal miners, giving affected individuals the right to work in a reduced dust environment. Another program is the Asbestos Medical Surveillance Program (AMSP) (external link), administered by the Navy Environmental Health Center. The Occupational Safety and Health Administration (OSHA) asbestos standard requires that chest radiographs obtained for surveillance of those exposed to asbestos be interpreted and classified by a B Reader, radiologist, or physician with expertise in pneumoconioses. OSHA (external link) also specifies B Readers and the International Labour Office (ILO) Classification in its asbestos safety and health standards for general industry, construction, and shipyard employment.

Physicians and other health care providers are encouraged, and sometimes required, to notify their State of diagnosed or suspected cases of occupational pneumoconioses, including silicosis and asbestosis. A chest radiograph classified or otherwise interpreted as consistent with the reportable disease is often considered sufficient evidence to require reporting. If physicians are not already aware of their State reporting requirements, they should contact their State to learn about any reporting requirements for which they may be responsible. Contacts for State Public Health Departments can be found on the Association for State and Territorial Health Officials (ASTHO) Web site (external link).

Balancing costs

When designing a monitoring program, it is important to weigh the cost of failing to detect true disease (false negatives) against the cost of falsely identifying disease (false positives) in health workers. All of the issues

discussed in the section on research and surveillance, including inter-reader variability, reader experience, blinding, and quality control apply in the setting of worker health monitoring. However, in the worker health monitoring setting, approaches to film classification have important social and economic implications. Individuals who have true disease but are not identified during health monitoring will not be protected from further exposure, and hence will likely suffer disease exacerbation. Ultimately, they may suffer impairment, disability, or premature mortality, with the ensuing economic and social costs of treatment, compensation, and reduced quality of life. In addition, failing to identify sentinel cases of disease may also result in failure to identify risky working situations, letting other workers continue to be at risk of hazards.

On the other hand, a health monitoring program that has a high rate of falsely detecting disease brings with it the social cost of unnecessary worker concern and the financial cost of medical follow-up testing. A health monitoring program may be impractical if the costs of procedures and follow-up are excessive compared to program benefits. There must be a balance between sensitive and practical surveillance and accurate procedures.

Two factors impacting sensitivity and specificity are 1) the point (or points) in the scale of abnormality that is chosen for decision making (e.g., further follow-up, removal from exposure), and 2) the use of single or multiple readers, and, in the latter case, how the multiple readings are summarized.

Single versus multiple readings

In some circumstances, a program organized around single readings of the majority of the radiographs may be satisfactory. Such programs may involve a single initial reading for all films, followed by a second reading for the subset that shows early abnormality. It is also advisable for a second reading to be performed in a small percentage of films initially classified as normal. As a matter of practicality, this percentage may be smaller for larger work forces. In this way, the program can be cost-effective, while at the same time safeguarding the objective of disease detection. Through use of accurate readers and through careful choice of the abnormality level that triggers further evaluation, a program can be sensitive to disease and fulfill its purpose without undue cost.

Multiple readings of radiographs can also be used and are employed by at least one ongoing monitoring program. All final determinations for the Coal Workers' X-Ray Surveillance Program are based upon agreement of two readers, using a specified algorithm [42CFR37 (external link)]. Data from this program are also used in population surveillance (see below).

Requiring readers to regularly interpret quality control films is considered useful in "calibrating" readers to classify films in a more consistent and precise manner [Fay 1959].

Whatever approach to radiographic monitoring is undertaken, it is critical that there be a formal process linking positive findings to organized responses that protect both the affected individual and similarly exposed co-workers.

Use of health monitoring data for population surveillance purposes

Population surveillance refers here to observations and actions involving groups of individuals. Information from health monitoring programs can frequently be useful for population surveillance. An example of this can be found on the Occupational Respiratory Disease Surveillance (ORDS) Web site. For this to be effective, care must be taken to ensure that the health monitoring information is representative of the population so that the prevalence statistics are valid and unbiased. Particular attention must be given to data management and analysis, and additional readings may be necessary to get reliable information. As already noted, identified cases of reportable diseases should be reported to State Public Health Departments as required by law. A listing of State Public Health Departments can be found at the Association for State and Territorial Health Officials (ASTHO) Web site (external link).

References

Coal Workers' X-Ray Surveillance Program. National Institute for Occupational Safety and Health. How can I learn more about my transfer options?

Asbestos Medical Surveillance Program. Navy Environmental Health Center
External Link: http://www-nehc.med.navy.mil/occmed/Asbestos.htm

Safety and Health Topics: Asbestos. Occupational Safety and Health Administration
External Link: http://www.osha.gov/SLTC/asbestos/index.html

Association for State and Territorial Health Officials
External Link: http://www.astho.org/

Specifications for Medical Examinations of Underground Coal Miners. 42CFR37
External Link: http://www.access.gpo.gov/nara/cfr/waisidx_02/42cfr37_02.html

Fay JWJ, Rae S. The Pneumoconiosis Field Research of the National Coal Board. *Ann Occup Hyg* 1959; 1:149-61.

Occupational Respiratory Disease Surveillance. National Institute for Occupational Safety and Health

Recommended Application of the ILO Classification System in Determining Government Program Eligibility

Draft proposal for public comment. The following should not be considered NIOSH policy but reflect

preliminary efforts to disseminate guidance on best reading practices. The final text will modified based on input received from stakeholders.

The information on this page refers to radiograph readings that are made for certain federal programs that award disability benefits.

Summary of Recommendations

ILO Classification:	Refer to program
B Reader certification:	Refer to program
Multiple readings:	Refer to program
Blind reading:	Refer to program
Quality control films:	Refer to program

Further information

Physicians should follow federal regulations regarding medical testing for the Black Lung Benefits Program

Physicians performing medical testing for the Black Lung Benefits Program should follow regulations found in 20CFR718.102, 718.202, and Appendix A (external link). These regulations specify what medical testing must be done as well as the film and equipment that must be used for radiography. Chest radiographs must be classified using the International Labour Office (ILO) Classification system.

Physicians should follow federal regulations regarding medical diagnosis of chronic silicosis for Energy Employees Occupational Illness Compensation Program

The Energy Employees Occupational Illness Compensation Program Act of 2000 provides compensation for employees or eligible survivors of employees of the Department of Energy, its predecessor agencies, and its contractors and subcontractors who became ill as a result of the work performed in the production and testing of nuclear weapons. Silicosis is a covered condition under the Act. Physicians should follow regulations regarding medical diagnosis of chronic silicosis for the Energy Employees Occupational Illness Compensation Program (external link). A written diagnosis of silicosis must be made by a medical doctor along with a chest radiograph, results of other imaging techniques, or a lung biopsy. If a chest radiograph is submitted, it must be interpreted by a NIOSH certified B Reader.

Coal workers diagnosed with pneumoconiosis (black lung) should contact the nearest Black Lung Benefits Office to determine their eligibility

The Federal Black Lung Benefits Program is completely separate from the State Worker's Compensation programs. Some miners may qualify for one program and not the other. The Black Lung Benefits Act was passed in 1969 [20CFR718, 20CFR725 (external links)]. This Federal program provides payments and medical treatment to coal miners who are totally disabled from pneumoconiosis (black lung) arising from their employment in or around the nation's coal mines. In select cases, payments may be paid to eligible surviving dependents. To find out about eligibility for Federal Black Lung Benefits, contact the nearest Black Lung Benefits Office (external link).

Workers diagnosed with pneumoconiosis should contact the State Office of Workers' Compensation to determine their eligibility

Federal benefits programs are completely separate from State Workers' Compensation programs. Some individuals may qualify for one program and not the other. State disability benefits and compensation differ by state, so contact the State Office of Worker's Compensation (external link) to learn about compensation from the State Government. There are often time limits that apply to how long individuals have to make a claim after the worker is diagnosed with a compensable disease, so workers should be encouraged to avoid delay in contacting the State Office.

Workers diagnosed with silicosis due to mining of tunnels at Department of Energy Facilities in Nevada or Alaska should contact the Energy Employees Occupational Illness Compensation Program to determine their eligibility

The Energy Employees Occupational Illness Compensation Program Act of 2000 provides compensation for employees or eligible survivors of employees of the Department of Energy, its predecessor agencies, and its contractors and subcontractors who became ill as a result of the work performed in the production and testing of nuclear weapons. Silicosis is a covered condition under the Act. Eligible employees are those who were exposed to silica for a total of at least 250 work days during the mining of tunnels at a Department of Energy facility located in Nevada or Alaska for tests or experiments related to an atomic weapon. Individuals with these exposures and seeking compensation should contact the Energy Employees Occupational Illness Compensation Program [EEOICPA Web site (external link)].

Employers should follow the OSHA asbestos standard

The Occupational Safety and Health Administration (OSHA) asbestos standard (external link) requires that chest radiographs obtained for surveillance of those exposed to asbestos be interpreted and classified by a B Reader, radiologist, or experienced physician with expertise in pneumoconioses. OSHA also specifies B Readers and the International Labour Office (ILO) Classification in its asbestos safety and health standards for general industry, construction, and shipyard employment.

References

Standards for Determining Coal Miners' Total Disability or Death Due to Pneumoconiosis. 20CFR718
External Link: http://www.dol.gov/dol/allcfr/Title_20/Part_718/toc.htm

Claims for Benefits Under Part C of Title IV of the Federal Mine Safety and Health Act, As Amended. 20CFR725
External Link: http://www.dol.gov/dol/allcfr/Title_20/Part_725/toc.htm

Black Lung Benefits Offices. Division of Coal Mine Workers' Compensation Program and District Offices, Department of Labor
External Link: http://www.dol.gov/esa/contacts/owcp/blcontac.htm

Energy Employees Occupational Illness Compensation Program Act of 2000, as described on the US Department of Labor compliance assistance web site.
External Link: http://www.dol.gov/esa/regs/compliance/owcp/ca_eeoic.htm

State Workers' Compensation Officials. US Department of Labor
External Link: http://www.dol.gov/esa/regs/compliance/owcp/wc.htm

Safety and Health Topics: Asbestos. Occupational Safety and Health Administration
External Link: http://www.osha.gov/SLTC/asbestos/index.html

Recommended Application of the ILO Classification System in Compensation Settings

Draft proposal for public comment. The following should not be considered NIOSH policy but reflect preliminary efforts to disseminate guidance on best reading practices. The final text will modified based on input received from stakeholders.

The International Labour Office (ILO) recognizes the limitations of the use of the ILO Classification System in the decision making process for awarding compensation. The 2000 ILO Classification Guidelines state explicitly that classification "does not imply legal definitions of pneumoconiosis for compensation purposes and does not set or imply a level at which compensation is payable" [ILO 2000]. As discussed in the Medical Diagnosis section, the diagnosis of pneumoconiosis is best made by considering both the chest radiograph and other data, including the medical and occupational history, physical examination, other types of chest imaging and laboratory tests, and sometimes biopsy.

Despite these cautions, ILO classifications that fit certain definitions of abnormality are frequently considered in decisions concerning compensation awards. To achieve consistency and fairness in these proceedings, it is important that such classifications be standardized and reproducible across geography and time. Societal

considerations, such as affordability of evaluations and consequences of misclassification, are important considerations in compensation proceedings. Balancing these considerations is an issue of both science and societal values. Differing venues may legitimately choose different approaches, so these recommendations are offered as guidance rather than absolutes.

Summary of Recommendations

ILO Classification:	Desirable
B Reader certification:	Desirable
Multiple readings:	Desirable (with caveats)
Blind reading:	Desirable
Quality control films:	Desirable

Further information

Follow guidelines for expert witnesses

The American Medical Association and the American College of Radiologists and other medical organizations have published guidelines for physicians serving as expert witnesses. All of them discuss the need to be impartial, objective, and unbiased. Testimony must be scientifically valid and be able to withstand peer review [ACR 2002, AMA].

Chest radiograph readings and compensation

The ILO system provides for classification of parenchymal and pleural abnormalities. Parenchymal lung abnormality is classified on a 12-point scale ranging from 0/- to 3/+. Pleural abnormalities are divided into pleural plaques (localized pleural thickening), costophrenic angle obliteration and diffuse pleural thickening. Parenchymal abnormalities classified as 1/0 or greater are frequently considered to be consistent with the presence of pneumoconiosis. In general, this threshold of 1/0 is also used in compensation proceedings to document the presence of pneumoconiosis. As stated above, the ILO itself states that classification does not imply definitions of pneumoconiosis for compensation purposes [ILO 2000].

Single versus multiple readings

Despite concerns raised by the ILO, use of ILO Classification as performed by B Readers can be a useful tool in compensation proceedings. As the ILO states, “the object of classification is to codify the radiographic abnormalities of the pneumoconioses in a simple, reproducible manner” [ILO 2000]. Reproducibility is critical to using chest radiographic interpretations in compensation settings. Lack of accuracy and imprecise interpretation could lead to unequal treatment of claimants. To limit the impact of reader variability in scoring chest radiographs

relative to ILO standard films, ILO recommends "that, in epidemiological studies, at least two, but preferably more, readers each classify all radiographs independently" [ILO 2000]. It may seem reasonable to consider applying the same standard in compensation proceedings after considering issues related to the effectiveness of the use of multiple readings (addressed below) and possible associated costs.

There are important caveats that should be considered in applying a multiple reading approach to compensation proceedings. As already discussed, there is inter- and intra-reader variability. Groups composed of individual readers with extreme tendencies of under- or over-reading of abnormalities can be expected to produce similarly extreme interpretations. Thus, use of multiple readings in itself will not guarantee accurate readings. There are several ways to deal with this issue and improve accuracy. One would be to select readers who are in the mainstream of reading tendencies and exclude those with extreme tendencies. This can be achieved in epidemiological studies by analyzing how groups of readers interpret the same films. In compensation proceedings, exclusion of readers may raise many issues and difficulties. Although desirable, selection based on quality control evaluation involving classification of test films does not necessarily guarantee how readers will classify actual unknown films. Similarly, interval quality control evaluation separate from actual readings, which is also desirable, does not guarantee that actual readings will be free of reader bias.

One potential solution to these issues might be to perform continuous quality control by mixing quality control ("calibration") films with those being read for compensation applications, with the identity of both sets of films hidden to prevent recognition of their source. Providing feedback comparing the readers' film classifications to previously-established classifications can be used as a tool to improve reader performance [Sheers 1978]. Furthermore, if sufficient numbers of quality control films are classified to achieve appropriate statistical power, evaluation of how readers classify these films can provide objective evidence of readers' performance and possible bias. However, the effectiveness of this approach in compensation proceedings has not been documented.

Another caveat to consider is how the classifications of multiple readers are combined into a single summary classification. Obtaining multiple readings and deriving summary classifications is a common strategy for improving precision. However, the approach to summarization can have an important effect on results. For instance, even if readers are providing accurate readings, methods that require consensus may reduce the proportion of radiographs read as positive to that, or below that, of the most stringent reader, thus compromising accuracy. On the other hand, use of median determinations will tend to reflect the center of the distribution of readers. Assuming the distribution is balanced, this may improve precision without negatively affecting accuracy. Although increasing the number of readers would theoretically increase the precision of readings, cost and complexity also increase with the number of readers. Depending on local circumstances, views may vary as to the specific number of readers that is optimal.

Classify films blind to medical, exposure, and contextual information

When classifying radiographs it is desirable that the reader does not consider any other information about the individuals being studied, including medical data, exposure information, the context and consequences of the

reading, or other readers' interpretations. Awareness of supplementary details specific to individuals can introduce bias into results. This information should not be available to the reader at the time of chest radiograph classification but can be considered later when the chest radiograph classification is integrated with other clinical information to formulate a diagnostic assessment. Reading in a blinded fashion also has the potential to limit the appearance that conflict of interest is affecting results.

References

International Labour Office (ILO). Guidelines for the Use of the ILO International Classification of Radiographs of Pneumoconioses, Revised Edition 2000 (Occupational Safety and Health Series, No. 22). International Labour Office: Geneva, 2002.

American College of Radiology (ACR). ACR Practice Guideline on the Expert Witness in Radiology. 2002 (Res. 43). Effective 1/1/03 (This Web site is not a direct link.)
External Link: http://www.acr.org/dyna/?doc=departments/stand_accred/standards/standards.html

American Medical Association. H-265.994, Expert Witness Testimony. (Sub. Res. 223, A-92; Appended: Sub. Res. 211, I-97; Reaffirmation A-99) (This Web site is not a direct link.)
External Link: http://www.ama-assn.org/ama/noindex/category/11760.html

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Fay JWJ, Rae S. The Pneumoconiosis Field Research of the National Coal Board. *Ann Occup Hyg* 1959; 1:149-61.

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Best Technical Practices

Draft proposal for public comment. The following should not be considered NIOSH policy but reflect preliminary efforts to disseminate guidance on best reading practices. The final text will modified based on input received from stakeholders.

Radiograph classifications constitute a valid methodology for detecting and assessing certain occupationally-induced lung diseases. To this end, the International Labour Office (ILO) International Classification of Radiographs of Pneumoconioses was designed as a systematic mechanism for assessing occupational lung disease. The usefulness of the approach has been demonstrated repeatedly. Classifications of radiographs show clear

correlations with dust exposure, lung dust burden, lung pathology, and mortality [Attfield 1992, Ruckley 1984, Miller 1985]. Elsewhere, for example, classifications of patients with asbestos related lung disease were correlated with lung function [Cotes 1988].

In order for the method to be applied optimally, the best reading practices shown in these pages should be adopted. Moreover, the following technical aspects should be given consideration.

Good-quality radiographic techniques and equipment are essential

It has long been recognized that both the technique and the equipment used for chest radiographic imaging of dust-exposed workers affect the radiographic appearance of lesions, and that this can influence the classification of a radiograph for disease. Consequently, readers may find it difficult to use the International Labour Office (ILO) Classification system if the quality of chest radiographs is suboptimal [ILO 2000].

When taking radiographs for assessment using the ILO Classification, a protocol giving clear quality control guidelines should be adopted and employed. For example, in the Coal Workers' X-Ray Surveillance Program, administered by the National Institute for Occupational Safety and Health (NIOSH), there are strict requirements on the radiograph film, exposures, and equipment that must be used. Additionally, before films may be submitted under the program, sample images from each radiograph unit must be evaluated and approved by NIOSH [42CFR37 (external link)].

The role of the NIOSH B Reader Program

In the United States, the B Reader Program has played a major role in advancing knowledge of radiographic classification using the ILO system. The B Reader certification examination, administered by NIOSH, is a rigorous evaluation of physicians' capability to identify and appropriately categorize radiographic changes of dust-related lung disease.

Physicians who classify chest radiographs for certain federal surveillance programs may be required to be an A or B Reader. For example, the Coal Workers' X-Ray Surveillance Program (CWXSP), as mandated by the Federal Mine Safety and Health Act of 1977, requires that physicians who classify radiographs for the program be A or B Readers for the first reading and B readers for subsequent readings [42CFR37 (external link)]. The Asbestos Medical Surveillance Program (AMSP) (external link), administered by the Navy Environmental Health Center, requires that radiographs be read by a local radiologist for the first reading and then classified by a B Reader for the second reading.

The Occupational Safety and Health Administration (OSHA) asbestos standard (external link) requires that chest radiographs obtained for surveillance of those exposed to asbestos be interpreted and classified by a B Reader, radiologist, or experienced physician with expertise in pneumoconioses. OSHA also specifies B Readers and the

ILO Classification in its safety and health standards for general industry, construction, and shipyard employment.

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Cotes JE, King B. Relationship of lung function to radiographic reading (ILO) in patients with asbestos related lung disease. *Thorax* 1988; 43(10):777-83.

Asbestos Medical Surveillance Program. Navy Environmental Health Center
External Link: http://www-nehc.med.navy.mil/occmed/Asbestos.htm

Safety and Health Topics: Asbestos. Occupational Safety and Health Administration
External Link: http://www.osha.gov/SLTC/asbestos/index.html

◀ Issues in Radiographic Interpretation

Resources ▶

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NIOSH Safety and Health Topic:

Chest Radiography

Resources

This section contains a listing of all the references (journal articles, books, Web sites, federal laws and regulations) used on this Web site as well as additional information related to the topics of chest radiography, the International Labour Office (ILO) Classification system, and the pneumoconioses.

If you are unable to find the information you are looking for on this Web site, please contact the B Reader Program office at (888) 480-4042 or email CWHSP@cdc.gov, and we will be happy to assist you.

Journal Articles

American Thoracic Society. Diagnosis and Initial Management of Nonmalignant Diseases Related to Asbestos. *Am J Respir Crit Care Med* 2004;170:691-715.

Attfield MD, Morring K. An investigation into the relationship between coal workers' pneumoconiosis and dust exposure in U.S. coal miners. *Am Ind Hyg Assoc J* 1992; 53:486-92.

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Chest Radiography (Draft for discussion)

Normal Chest Radiograph

Topic Index:

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NIOSH B Reader Certification Program

B Reader Information for Medical Professionals

Ethical Considerations for B Readers

NIOSH Certified B Readers List

Web sites

American College of Radiology
External Link: http://www.acr.org/s_acr/index.asp

American College of Radiology (ACR). ACR Practice Guideline on the Expert Witness in Radiology. 2002 (Res. 43). Effective 1/1/03 (This Web site is not a direct link.)
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External Link: http://www.ama-assn.org/ama/noindex/category/11760.html

Asbestos Medical Surveillance Program. Navy Environmental Health Center
External Link: http://www-nehc.med.navy.mil/occmed/Asbestos.htm

Association of Occupational and Environmental Clinics
External Link: http://www.aoec.org/

Association for State and Territorial Health Officials
External Link: http://www.astho.org/

Black Lung Benefits Act (BLBA)
External Link: http://www.dol.gov/dol/compliance/comp-biba.htm

Black Lung Benefits Offices. Division of Coal Mine Workers' Compensation Program and District Offices, Department of Labor
External Link: http://www.dol.gov/esa/contacts/owcp/blcontac.htm

Black Lung Benefits Program. Division of Coal Mine Workers' Compensation Program and District Offices, Department of Labor
External Link: http://www.dol.gov/esa/regs/compliance/owcp/bltable.htm

Black Lung Clinics Program. Bureau of Primary Health Care, Health Resources and Services Administration
External Link: http://bphc.hrsa.gov/blacklung/default.htm

Campaign to End Black Lung Now and Forever
External Link: http://www.msha.gov/s&hinfo/blung/homepage.htm

Coal Workers' Health Surveillance Program. National Institute for Occupational Safety and Health

Coal Workers' X-Ray Surveillance Program. National Institute for Occupational Safety and Health. How can I learn more about my transfer options?

Energy Employees Occupational Illness Compensation Program Act of 2000, as described on the US Department of Labor compliance assistance web site.
External Link: http://www.dol.gov/esa/regs/compliance/owcp/ca_eeoic.htm

Federal Mine Safety & Health Act of 1977
External Link: http://www.msha.gov/regs/act/acttc.htm

Federation of State Medical Boards
External Link: http://www.fsmb.org/members.htm

Mine Safety and Health Administration
External Link: http://www.msha.gov

Occupational Respiratory Disease Surveillance. National Institute for Occupational Safety and Health

Roentgenographic Interpretation Form. B Reader Certification Program. National Institute for Occupational Safety and Health

Safety and Health Topics: Asbestos. Occupational Safety and Health Administration
External Link: http://www.osha.gov/SLTC/asbestos/index.html

State Workers' Compensation Officials. US Department of Labor
External Link: http://www.dol.gov/esa/regs/compliance/owcp/wc.htm

Federal Laws and Regulations

Claims for Benefits Under Part C of Title IV of the Federal Mine Safety and Health Act, As Amended. 20CFR725
External Link: http://www.dol.gov/dol/allcfr/Title_20/Part_725/toc.htm

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Specifications for Medical Examinations of Underground Coal Miners. 42CFR37
External Link: http://www.access.gpo.gov/nara/cfr/waisidx_02/42cfr37_02.html

Standards for Determining Coal Miners' Total Disability or Death Due to Pneumoconiosis. 20CFR718
External Link: http://www.dol.gov/dol/allcfr/Title_20/Part_718/toc.htm

◀ Recommendations for Applying the ILO International Classification of Radiographs of Pneumoconioses

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NIOSH Home | NIOSH Search | Site Index | Topic List | Contact Us

NIOSH Safety and Health Topic:

Chest Radiography

Resources

This section contains a listing of all the references (journal articles, books, Web sites, federal laws and regulations) used on this Web site as well as additional information related to the topics of chest radiography, the International Labour Office (ILO) Classification system, and the pneumoconioses.

If you are unable to find the information you are looking for on this Web site, please contact the B Reader Program office at (888) 480-4042 or email CWHSP@cdc.gov, and we will be happy to assist you.

Related NIOSH Topic Pages

Asbestos
Coal Workers' Health Surveillance Program
Occupational Respiratory Disease Surveillance
Pneumoconioses

Journal Articles

American Thoracic Society. Diagnosis and Initial Management of Nonmalignant Diseases Related to Asbestos. *Am J Respir Crit Care Med* 2004;170:691-715.

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Chest Radiography (Draft for discussion)

Normal Chest Radiograph

Topic Index:

Evaluating Occupational Lung Disorders

History of Radiograph Reading

ILO Classification

Applications for Chest Radiography in Occupational Health

Issues in Radiographic Interpretation

Recommendations for Applying the ILO International Classification of Radiographs of Pneumoconioses

▸Resources

Fay JWJ, Rae S. The Pneumoconiosis Field Research of the National Coal Board. *Ann Occup Hyg* 1959; 1:149-61.

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NIOSH B Reader Certification Program

B Reader Information for Medical Professionals

NIOSH Certified B Readers List

On This Page...

Related NIOSH Topic Pages

Journal Articles

Books

Web Sites

Federal Laws and Regulations

Books

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◀ Recommendations for Applying the ILO International Classification of Radiographs of Pneumoconioses

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